bered how enormous is the extent of its cultivation in their hands. It is this fact which has won it its official status, as though poor in quinine its quality is tolerably uniform, and being easily grown its supply can always be depended on. Prof. Flückiger gives a figure of the plant as well as of *Cinchona Ledgeriana*—the quinine bark *par excellence*—and of *Remijia pedunculata*, one of the sources of the *Cinchona cuprea* which has of late years been poured into European markets from South America

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MARINE SURVEYING

A Treatise on Marine Surveying. Prepared for the use of younger Naval Officers, by the Rev. J. L. Robinson, B.A., Royal Naval College. (London: Murray, 1882.)

THIS book has been written apparently with the view of enabling young naval officers to cram themselves sufficiently to pass the examination in surveying at the Royal Naval College, and it must be conceded displays considerable industry on the part of Mr. Robinson, who has evidently taken pains to go through the examination papers on surveying from their commencement, to see what questions are usually asked, and in what form they could be best answered; and has besides consulted a large number of works bearing on surveying, a list of which he gives at the commencement of his treatise; but we confess we are much disappointed that with such excellent materials, so poor a result should have been produced, for, with the exception of the chapter on tides, which in its way is excellent, the work is of very little value, and rather reminds us of that treatise of—

> "The young lady of Buckingham
> Who wrote about geese and stuffing 'em,
> But found out one day
> She'd neglected to say
> A word in her book about plucking 'em."

Mr. Robinson says in his preface "he has had no intention to write a handbook for the use of the practical surveyor," and that "such an intention might fairly be regarded as an impertinence in one who has never been engaged in the practical work of the profession," but that he has had rather "the examination room and its requirements before him." But did it not strike Mr. Robinson that the practical surveyor selected to examine the candidates might ask questions upon which he has neglected to touch, and that consequently his treatise might fail to ensure success in the "examination room," notwithstanding the valuable hints he has received from Staff-Commander Johnson and his friend of great experience as a first-class surveyor?

The first chapter consists of extracts from Admiralty publications, but we recommend the officers at the college to consult those publications for themselves, more especially the Admiralty list of abbreviations, as the illustrations in this work give a poor representation of the symbols and signs used by the draughtsman and engraver.

The second chapter, on the Construction and Use of Scales, and the sixth, on Instruments, are derived principally from Heather. Here again we prefer the original to the copy.

The third chapter, on Laying off Angles, merely contains a brief description of the methods of plotting angles by chords with a small radius. On this we would remark that the real value of plotting angles by chords consists in their being plotted with long radii, as any practical draughtsman could have informed the author.

The fourth chapter is a most elaborate analysis of the method of Fixing a Position by Angles, &c. Surveyors take sextant angles, principally, to fix their positions when sounding, and invariably use the station pointer for that purpose; this chapter therefore seems to us to be firing a 12-ton gun at a sparrow.

The fifth chapter, on Charts and Chart Drawing, is rather a description of the method of map construction, and contains some mis-statements. Evidently Mr. Robinson is not well acquainted with the mode of constructing charts at the Admiralty or by surveyors, as he states in one paragraph that circumpolar charts are usually constructed on the gnomonic projection, whereas we are not acquainted with one Admiralty circumpolar chart on this projection. It is true a diagram is published to facilitate the practice of great circle sailing but no circumpolar chart.

The fact is all marine surveyors project their work on the gnomonic projection, and as the smallest scale in use is an inch to a mile, it is evident that the errors of this projection are very slight, as the largest sheet of paper that can be worked at conveniently is about six feet square. When the original surveys arrive at the Admiralty the Hydrographer decides in what form they shall be engraved and published. If the surveys are plans of harbours, they are usually published on the gnomonic projection (as they were originally drawn); if the survey is of a coast, or to be incorporated in a coast, or general sheet, it is transferred to the mercatorial projection, for which the meridional parts of the spheroid are used. Charts of the circumpolar region are however published on an arbitrary projection, in which the parallels of latitude are drawn as concentric circles at equal distances from the pole.

Chapter seven is on Base Lines. Now base lines are principally of use to the marine surveyor as the quickest method of starting his work, which, when it extends over a large area, almost invariably depends eventually for its scales on astronomical observations.

Mr. Robinson states that it is impossible to fix the position *exactly* by means of a sextant. Here we must differ from him, and will give one instance to the contrary. When the question of the boundary between the United States and British North America was decided, and the 49th parallel was fixed on, Admiral Sir George Richards then in command of H.M. surveying vessel *Plumper*, at Vancouver's Island, was directed to ascertain the position of this boundary line on the western seaboard of North America. This he did with a sextant, and buried a mark in the ground on the position of the 49th parallel as ascertained by himself. The Americans sent a party for the same purpose with a zenith sector and altazimuth and when they had fixed the position of the 49th parallel by these means, the difference between the two results was found to be less than 100 feet! It is of course as well that nautical surveyors should know the various methods employed in obtaining accurate bases for geodetical measurements, but for marine surveying the same nicety is not required as in measuring the arc of a meridian, and it cannot be too often impressed on the mind of the aspirant in surveying that over accuracy (that is such minuteness as cannot be represented on paper) is loss of time.

The eighth chapter is on Triangulation, and is more worthy of attention than those preceding. If we remember rightly, there was only one three-feet theodolite used in the Ordnance Survey of Great Britain, which instrument is the property of the Royal Society. In fact, so far as we are acquainted, there are only two three-feet theodolites in existence, Ramsden's, and another used in the Great Trigonometrical Survey of India.

The observation that very distant stations are generally observed at night is now subject to correction, as the heliostadt has rendered it quite as easy to observe by day, in fact, in some of our marine surveys, triangles whose sides were 60 miles in length, have been obtained with these instruments, and an eight-inch theodolite, with the greatest ease. With the eight-inch theodolite, and by means of repeating the main angles round the circle, very accurate results may be obtained; and the spherical excess has to be allowed for, and deducted, in order to make the triangles plane, for in all nautical surveys the chord of the arc is used both for calculation and plotting.

The ninth chapter, on Levelling, contains not only an account of levelling, but also of obtaining heights by means of the barometer and thermometer, but totally neglects the method in general use by surveyors, viz. by angles of elevation and depression with a theodolite. For travellers the barometer and thermometer give an approximation of the elevation, which is exceedingly useful in an unsurveyed district. For work requiring extreme accuracy careful levelling is required, but for nautical work the principal use of the level is to ascertain the exact difference between the zero of the tide gauge and some permanent mark on shore, so that a fixed datum can always be referred to for reduction of soundings in future. The heights of hills are almost invariably obtained by angles of elevation and depression, and the results so closely approximate to the truth that it is waste of time to do more, unless results less than five or six feet in error are absolutely requisite.

The tenth chapter is on Tides, and is, as has been before mentioned, well worthy of perusal, in fact, it is the most complete popular description we remember to have seen; and if compiled entirely by Mr. Robinson from the books he has consulted reflects great credit on him, and we can but wish he had paid the same attention to the other parts of his treatise.

We think, if we remember rightly, that it was in one of the Arctic voyages, that of Sir John Ross, that the influence of atmospheric pressure on the rise of the tide was first observed, but the fact is well known now, and is always allowed for by surveyors when ascertaining the mean level of the sea. This subject is of considerable practical importance, for it is sometimes the only guide we possess by means of which we can reduce our soundings to the same depth as those obtained at previous epochs. For instance, if the datum-mark to which the soundings have been referred, has, in the course of time, disappeared, the surveyor's first work is to ascertain the height on his gauges of the mean level of the sea. This he does by obtaining day and night observations for five or six consecutive high and low waters, carefully registering the barometer at the same time. Then meaning the results and allowing for the atmospheric pressure, it is astonishing how closely they agree. The mean level having been found, it is very easy to reduce the soundings to the former datum. For instance, if the soundings are reduced to low water ordinary springs, and their rise at springs is 16 feet, it is evident that the soundings must be reduced to 8 feet below mean level of the sea, to enable them to be compared with those previously obtained.

In his paragraph (201) on tide-gauges, Mr. Robinson recommends a string from a float over a pulley. It must be either a chain or wire, as a string is far too subject to contraction and expansion from atmospheric changes.

Self-registering tide-gauges are, we are glad to say, becoming much more common than they were, and we trust to see them established at every important point in the United Kingdom.

The eleventh chapter, on Soundings, may do very well to enable a sub-lieutenant to answer some questions in the examination-room, but is useless in practice.

Few surveyors think it necessary to accurately protract on a chart the position of the objects they use for sounding transits (Art. 210). Often the back mark is too far off to appear at all on the sheet, and the farther off it is the better, provided the atmosphere is clear; for a front mark the first conspicuous object in the foreground is seized—a conspicuous tree, the chimney of a house, the angle of a hedge, a boat hauled up on the beach, &c. If the back object is sufficiently far off, the lines of soundings are practically parallel, and the same mark may be used for the whole survey. It is also requisite to cross the lines of soundings, to avoid any chance of error. The sounding on the chart depends (1) on the leadsman, (2) on the officer fixing and registering, (3) on the tidal register, and (4) on the reductions being correctly made. Now there may be a mistake in either one of these, and consequently it is advisable to always cross the lines of soundings as a check. We have found that as good a method of checking the correctness of the results as any, is by running along the contour lines, as defined by soundings obtained at right angles to those lines.

Another remark on soundings we must also take exception to, viz. that (Art. 213) it is usual to make a reduction of a couple of feet below low water in doubtful cases.

With respect to under-currents (Art. 221), Mr. Robinson appears not to be aware of the methods pursued by Sir G. Nares in the *Challenger*, and Capt. Wharton in the *Shearwater*.

Chapters twelve and thirteen, on Chronometers, and Meridian Distances, are principally derived from Admiral Shadwell's notes on the management of chronometers, and here we recommend the student to the original rather than the copy.

The method of calculating meridian distances expounded by Dr. Tiarks, and fully explained by Sir Chas. Shadwell, is invariably used by nautical surveyors, and the results thus obtained have hitherto closely approximated to the later determinations by means of the electric telegraph.

Chapter fourteen, on the method of Plotting a Survey, deals almost exclusively with the small plans required by the examination papers at the Naval College, and as it instructs the student to plot *out* from the base line (which is never done in practice) cannot be recommended.

The method of plotting adopted in practice is to calculate out from the base line to the extreme points of the survey, or to the extreme points that will appear on any one sheet of paper, and then to plot *in*. Every practical draughtsman knows that it is far easier to say, "draw a straight line" than to do it, and that an infinite amount of trouble is saved by plotting in towards small triangles from large, as the errors of the plotter are then being constantly reduced, whereas in plotting *out* they are being continually enlarged. In fact we venture to say that no one is competent to write an article on plotting who has not been in the habit of projecting surveys for no one else can understand the extreme nicety required to make three lines from three stations to the same object coincide in one point.

It is possible that Mr. Robinson has compiled this work in hopes the Admiralty may order it to be accepted as the text-book on surveying at the College. We trust, however, that their Lordships may be better advised on the point. Already we have one book, ordered to be used, which contains a theory on winds, not by any means accepted by meteorologists, and this theory has at present to be learnt by all the younger naval officers. Now we have no objection to any one theorising on wind, or any other subject, but what we do object to is that a book containing such theories should be ordered to be the standard work at the colleges, simply because the gentleman who wrote it holds, and worthily holds, a prominent position there. We think that although theories should not be absolutely excluded from textbooks, they should deal principally with well-ascertained facts, leaving the student to develop for himself a theory from those facts.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Natural Selection and Natural Theology

A PERUSAL of Dr. Romanes' article on Natural Selection and Natural Theology, in the *Contemporary Review* for October, 1882, suggests a few remarks upon one or two points, which may not be out of place.

One would quite agree with Dr. Romanes in "insisting on the essentially distinct character of natural science and natural theology as separate departments of human thought." True as that is, in a just sense, how does it follow that there "is no point of logical contact between" the two? Does this mean that because natural phenomena can be reduced to laws and sequences of cause and effect, no legitimate or rational inference can be made by the human mind to a *causa causarum?* It would seem so, and that it must be so to justify his very thoroughgoing conclusion: (1) That Darwin's theory explodes *particular design* (which he chooses to identify with special or independent creation); and (2) that it does not allow us rationally to introduce the conception of "an ultimate cause of a psychical kind pervading all nature," the theory having "no point of logical contact with the theory of design even in the larger sense." That is, a *raison d'être* in particular is proved to be absurd; behind all secondary causes, one such may possibly exist, but it is not to be legitimately thought of!

Or does he mean only that Darwin's theory need not, and legitimately should not, concern itself with philosophy and natural theology? Very well: then let the disciples practise what they preach, and imitate their revered master, who was content to maintain that species became what they are by descent with modification, instead of by independent creation, leaving untouched the question whether or not they were designed to be what they are. If there be "no logical contact" between Darwin's theory and the theory of design, then this renowned investigator preserved more logical consistency than some of his followers: if he refrained because of "the essentially distinct character of natural science and natural theology," and because of his determination to consider only the former, he was no less consistent.

But after all, such questions may be consistent enough, and moreover they are inevitable; and so it is not wonderful that they are raised—and not rarely prejudged—on the scientific about as freely as on the theological side.

Anyway Darwin did not prejudge the question of design, while declining to discuss it, as is done, for instance, by the *dictum* that if the species of animals and plants were slowly evolved, the evidence of design has been utterly and for ever destroyed. That has been affirmed over and over, formerly in the main by the theologians, but now, when these have seen what it comes to, mainly by the anti-theologians; by both, seemingly, under a misapprehension of the real character of the evidence for design.

Dr. Romanes' view is fairly presented in his denial that, under our present knowledge, "the facts of organic nature furnish *evidence* of design of a quality other or better than any of the facts of inorganic nature." "Or, otherwise stated, there is nothing in the theory of natural selection incompatible with the theory of theism; but neither does the former theory supply *evidence* of the latter. Now this is just what the older theory of special creation did; for it would be proof positive of intelligent design, if it could be shown that all species of plants and animals were created, that is, suddenly introduced into the complex conditions of their life; for it is quite inconceivable that any cause other than intelligence could be competent to adapt an organism to its environment *suddenly*."

Is the writer of this quite sure that any cause other than intelligence could be competent to adapt existing organisms to their environment *gradually?* How has the former presumption—the contrary of which was quite inconceivable—been done away with? For this presumption arose, and had its full force under the consideration of animals and plants produced by natural propagation; and the then irresistible inference of intelligent design was drawn directly from their adaptations in themselves and to their environment; whence it was concluded that the series of phenomena must have been instituted somehow and at some time or times (sudden creation is no doctrine of natural theology) under intelligence. How is this presumption negatived or impaired by the supposition of Darwin's theory, that the ancestors were not always like the offspring, but differed from time to time in small particulars, yet so as always to be in compatible relations to the environment? We do not see how or why the inference, which was so cogent, should under the new showing become at once irrelevant and out of all logical connection with the facts of the case, which *quoad design* are just what they were. *Suddenness*—if that must needs be entertained—is of course incompatible with the Darwinian view, and also with the facts as we understand them; but *gradualness* is in nowise incompatible with design. Under the conception of Nature as the outcome of Divine intelligence, questions of time and mode, of generality and particularity, are well nigh devoid of real significance.

But what may be contended for, and what is probably meant, is that natural selection is a rival hypothesis to design, that it accounts for all adaptations in the organic world upon known physical principles, and so renders the idea of design superfluous, as some would say; or, as it is better stated by Dr. Romanes, renders the evidence of design from these adaptations of no other or better value than that from anything else in Nature. So that the argument from teleology "must now take its stand upon the broader basis of the order of nature as a whole." This last, sensible natural theologians are prepared for. But the whole is made up of parts; and it is a whole in which the designed (if such there be) and the contingent can never be accurately discriminated, in which, indeed, from the very nature of the case, limitation is inconceivable. This need not be wondered at, since we are equally unable to discriminate the two in human